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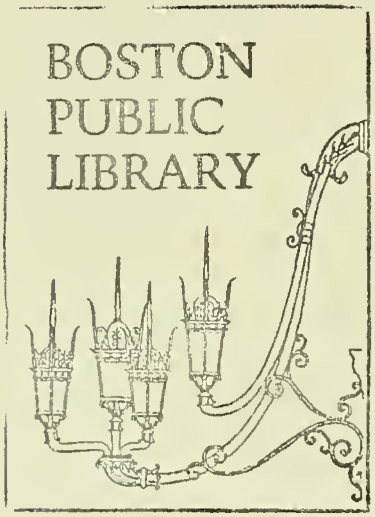

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Energy Conservation Through Site and Neighborhood Design in Boston

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ENERGY EFFICIENCY THROUGH SITE AND NEIGHBORHOOD DESIGN

January, 1984

A Report

by the

Boston Redevelopment Authority

Prepared by

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Project Manager

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under contract

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"Energy Conserving Development Regulations

For Site and Neighborhood Design"

to

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William L. Whitman

TABLE OF CONTENTS

I. Introduction. 1

A. Boston: The City. 4

B. Boston's Stuctural Stock 4

C. Boston: An Energy Profile. 6

II. The Boston Redevelopment Authority's New Energy Policies. . 11

A. Technology Review and Evaluation 11

B. The Energy Policies 20

C. Policy Applications 24

III. The Boston Zoning Code Made Energy Conscious. 25

A. Procedural Issues. 26

B. Floor Area Ratio Bonuses 27

C. Cluster Zoning 29

D. Solar 31

IV. Development Project Review 36

A. 121A 39

B. Commercial Area Revitalization Districts 39

C. Planned Development Areas. 39

D. Zoning Variances 40

E. Urban Renewal Areas. 41

F. Publications 43

G. Time of Use Rates 43

V. The Energy Systems Developers' Kit. 46

Footnotes 47

Bibliography 48

Appendix A: Large Scale Energy Systems Developer's Kit. . . . A1

Distribution List

TABLES AND FIGURES

Tables — Page

Table 1 Policy Option Evaluation Matrix 12
Table 2 Comparison of Electric Rates 44

Figures

Figure 1 Boston's District Steam System 10
Figure 2 Boston's Urban Renewal Districts 42

Introduction

I. INTRODUCTION

This report summarizes efforts which spanned nearly two years at the Boston Redevelopment Authority (BRA) under its contract with Argonne National Laboratory (ANL) to study Energy Conservation Through Site And Neighborhood Design (SAND). At the time SAND began, the BRA gave little attention to the efficiency or appropriateness of energy systems being designed for new developments. No mention of energy, systems efficiency, or conservation was made in the Boston Zoning Code or any other development regulation, except the State Building Code which contains a separate Article (20) on Energy Conservation. Thus, decisions which affected Boston's community energy systems were not recognized as such and were random in their effect.

At the time the funds for the SAND project were applied for, Boston and the rest of the nation were just beginning to adjust to the second doubling of oil prices in less than seven years. The possibility of shortages still loomed ominously over every aspect of our lives. Less than four years later, there is a world oil glut, United States and New England foreign oil imports have been significantly reduced, and OPEC appears to have considerably less power.

These more recent developments do not imply that energy conservation is no longer an important issue. It's importance has been permanently impressed upon us. On the other hand, we have come far beyond the stage of kneejerk reactions to conserve fossil fuels at any cost and in any way. Unlike the period prior to 1973 when energy scarcely merited a moment's thought, we now treat energy like any other budget item or investment option, but with a new attitude. First, it is acknowledged that the price and availability of fossil fuels are highly unpredictable. Second, underlying that uncertainty, the unshakable awareness exists that these earth resources are finite. Third, the environmental issues raised by burning fossil fuels become more pressing every year. Fourth, now that the prices of fossil fuels are no longer subsidized, their economic presence is felt more acutely by all, even during a glut.

How does all of this relate to the concerns of a city planner or redevelopment authority responsible for overseeing the construction of hundreds of millions of dollars of buildings which will consume millions of barrels of oil equivalent each year for as long as they stand (or until the oil runs out)? A planning agency should legitimately be concerned with, among other things, the safety and well-being of the residents in its jurisdiction, the health of the local economy, and the quality of the physical environment. Given that premise, what's important about energy to the planner is the impact of its cost and availability on office vacancy rates, on the decisions of corporations to locate in town or not, on local environmental quality - in other words, on the people in its jurisdiction in terms of their physical safety, their jobs, taxes, and disposable income, among other things.

The SAND analysis began with the formation of an advisory committee and review of existing development regulations and technologies appropriate for Boston. The committee work produced a set of policy recommendations (see Section II), which were then translated into a set of administrative tools (see Sections III, IV, and V and Appendix A). Those tools and policies are in place or being tested at this writing. Comprehensive evaluation of the impact of these products, however, must await some future date.

Our overall approach was to establish an institutional attitude which is receptive to and promotes, where possible, energy conserving design (see Policies and Development Review sections) and to create institutional vehicles for innovative approaches to energy conserving design by the private sector (see Zoning and Developers' Kits sections).

The products finally arrived at at the conclusion of the SAND project are those which the BRA deemed most appropriate from an institutional point of view, most effective from an administrative point of view, and most feasible from a political point of view. As is mentioned later in the report, the BRA lacks the capacity to perform extensive technical analyses or commit large amounts of staff time to an on-going energy systems or demand analysis and review process. This and other factors limited the kinds of tools which the BRA could realistically expect to employ on an on-going basis to promote energy conservation through site and neighborhood design. They are policy and incentive tools, rather than quantitative regulatory ones; and they are tools we hope will survive the vagaries of political, personnel, and economic changes.

A. Boston: The City[1]

As the economic center of the New England region, Boston provides significant professional, business, financial, communications, and public utility services, and serves as an important cultural, transportation, and government center. Boston has a population of 563,000 (1980 Census; down 78,077 from 1970) and provides 548,000 jobs. Job growth has been markedly strong in services, a trend which is expected to continue for the foreseeable future.

B. Boston's Structural Stock

Public and private investment have significantly transformed Boston's structural stock in the last two decades, in comparison with the legacy of obsolesence and decay consequent to the negligible levels of investment in the thirty years following the national depression of 1929.

The total current supply of private office space in Boston (both occupied and vacant) is estimated at 45 million square feet (gross floor area), over forty percent of which has been completed since 1960. New office construction currently underway or scheduled will add over four million square feet of new office space through 1984, with plans for the construction of an additional two million square feet of office space in 1985 and 1986 being well advanced. Most new office space, some of which is utilizing heat pumps and/or thermal storage, is electrically heated and cooled.

Also, declining office vacancies and a rise in office rental rates have induced the rehabilitation of a large amount of older commercial space. Government office space is estimated at 26 million square feet. Only the most recently constructed office space can be said to be energy efficient.

The growth in services and population has resulted in an increase in retail and wholesale employment and building space, which is estimated at 38 million square feet. Miscellaneous building space for proprietors and other businesses is estimated at 4 million square feet. A small percentage of this space is estimated to be in new or rehabilitated buildings.

Medical, higher education, and cultural institutions represent approximately 37 million square feet of building space and are expanding their facilities. Also, responding to the present shortage and projected growth in demand, the number of hotel rooms in Central Boston will rise from the present inventory of 6,925 to 11,357, representing a growth of 64 percent and approximately 3 million square feet.

Boston's housing stock showed a net gain from 1970-80 of 9,000 new dwellings, for a total housing stock of 241,914 units (218,457 occupied or approximately 300 million square feet) in response to extremely low vacancy rates. The net gain of four percent marked a notable advance in the condition of Boston's housing stock, with reported construction of 27,000 new dwellings more than compensating for the demolition of an estimated 18,000 units. In addition, 26,000 1- to 4-family owner-occupied dwellings have been upgraded through the City's grant-supported housing improvement program since 1975. While townhouses, rowhouses, and tripledeckers, of which Boston has a significant number, are inherently energy efficient, many of them have not been well maintained and are in need of weatherization and repair.

Of 6,000 condominium units created between 1970 and 1980, 3,000 emerged in 1979 and 1980 alone, representing an accelerating trend. Three-fourths of the City's housing stock is renter-occupied. Though Boston has a low proportion of owner-occupied housing, in comparison with other cities, 55 percent of the City's housing stock is in structures containing one to four units, and more than 80 percent of these structures are owner-occupied. Massachusetts' Energy Conservation section of the State Building Code ensures, to the extent possible, that renovation or conversion results in substantially improved energy efficiency.

Boston's industrial sector employment is up slightly since 1976, after a steady decline beginning in the early 1960's. This is due principally to Urban Development Action Grant-financed support of Boston's older industries (textile, leather, machinery, dairy) and the influx of high-technology related industry (electric machinery, instruments, fabricated metals, chemicals). The booming growth of service industries also has prompted growth in related fields, such as printing and publishing. Boston's industrial sector is estimated to occupy 18 million square feet of building space (approximately 4% of Boston's total floorspace), much of which is new or recently rehabilitated. The industrial sector appears to be shifting from oil- and gas-fired process industries to electricity consumers, such as the finance and insurance industries.

C. Boston: An Energy Profile

1) End Uses of Energy[2]

Boston's total direct energy bill for 1980 is estimated to have been 1.5 billion dollars, 87% of which left the local economy. More than half of the energy consumed in Boston (56.6%) is used in the commercial sector. The major consumers in this sector are hospitals, offices in the finance, insurance and real estate sectors, and schools and colleges. The residential sector represents about one quarter (25.2%) of the City's energy users. In all sectors, oil is the predominant fuel consumed (55.6%). In the non-residential sector, however, electricity represents a larger proportion (42.7%) of the total energy costs than any other single energy source.

In each sector, except for industry and transportation, the largest amounts of energy are needed for space heating purposes. In residential buildings, water heating is the second most important end use. In the commercial and municipal sectors, lighting is of second most importance.

In the industrial sector the largest portion of energy goes towards the generation of process steam and is oil-fired. Chemical, food and paper industries are the major industrial energy consumers.

2) Boston's Supply Systems

a) Electricity[3]

Boston's electric utility, Boston Edison Company (BECo), serves forty cities and towns in the Greater Boston area and is a member of the New England Power Pool (NEPOOL), the regional power sharing and planning association. BECo has peak generating capacity of 2,723 Megawatts (MW), consisting of a mix of 30% nuclear, 63% oil, and 7% gas turbines and diesel. In 1980, total system peak load (summer) was 2,100 MW (77% of BECo-owned capacity) and the total system energy requirements were 10.7 million megawatt-hours (MWH).

For the short term, heavy reliance on electricity has serious economic implications since BECo and NEPOOL are still approximately 60% dependent on imported oil. BECo is planning the conversion of much of its electric generating capacity from oil to coal and renewable sources of energy, such as hydro. The current uncertain status of coal conversions due to environmental concerns, BECo's recent decision not to build its new nuclear plant (Pilgrim II), and other factors, however, increase the likelihood that BECo will continue to depend heavily on oil throughout the 1980's.

b) Natural Gas[4]

Boston Gas Company (Boston Gas) sells and distributes gas to residential, commercial and industrial customers in the City of Boston and 73 other cities and towns in eastern Massachusetts. Boston Gas distributed 572 million cubic feet (MMCF) on the 1981 winter's peak day from a variety of sources: natural gas from major pipelines (47%), liquified natural gas (LNG) (50%), synthetic natural gas (2%), and propane (1%). Over the 1980-81 split-year, the 66,521 MMCF sendout was supplied by pipeline gas (77%), LNG (17%) and synthetic natural gas (6%).

In the short-term, Boston is unlikely to increase significantly its reliance on natural gas as a fuel source for two reasons. First, erratic price fluctuations of natural gas, oil will discourage large scale fuel switching between the two and most new construction will opt for electric heating and cooling in some form. Second, Boston Gas cannot greatly expand its service because gas supplies from domestic pipelines are constrained by market and regulatory factors. Proposals for new facilities to expand service are in "preliminary stages". In the long-term, Boston's position near the end of major pipelines could be improved significantly if proposed new pipelines were constructed and if domestic and Canadian supplies of gas were plentiful. However, these developments are uncertain at present.

c) District Heating

Boston's district heating system, one of the older district heating systems in the United States, provides steam to downtown Boston and the Back Bay. Unlike gas or electricity, steam sales are not subject to Massachusetts Department of Public Utilities regulation.

Baseload supply is provided by the Kneeland Street plant (near South Station) whose four dual-fired boilers have a sendout capacity of

1.1 million lbs/hour.* The units can burn either natural gas or #6 residual fuel (@ 0.5% sulphur). Additional or peaking capacity for the system comes from the Minot Street and Scotia Street oil-fired steam plants with a sendout capacity of 280,000 lbs/hr and 330,000 lbs/hr, respectively.

The distribution system's 22 miles of steam lines are concentrated in the downtown area between North and South Stations and in the Back Bay (bordered roughly by Stuart and Newbury Streets and Massachusetts and Huntington Avenues). See Figure 1. Major system extensions reach the Museum of Fine Arts on Huntington Avenue, the City Hospital complex on Albany Street in the South End, and areas of South Boston.

The largest portion of steam sendout (approximately 90 percent) serves space-conditioning, including about 80,000 tons of air-conditioning. Process heat demand accounts for the remainder. On a connected load equivalent cubage basis, the system provides for the space-conditioning needs of 830 million cubic feet annually.

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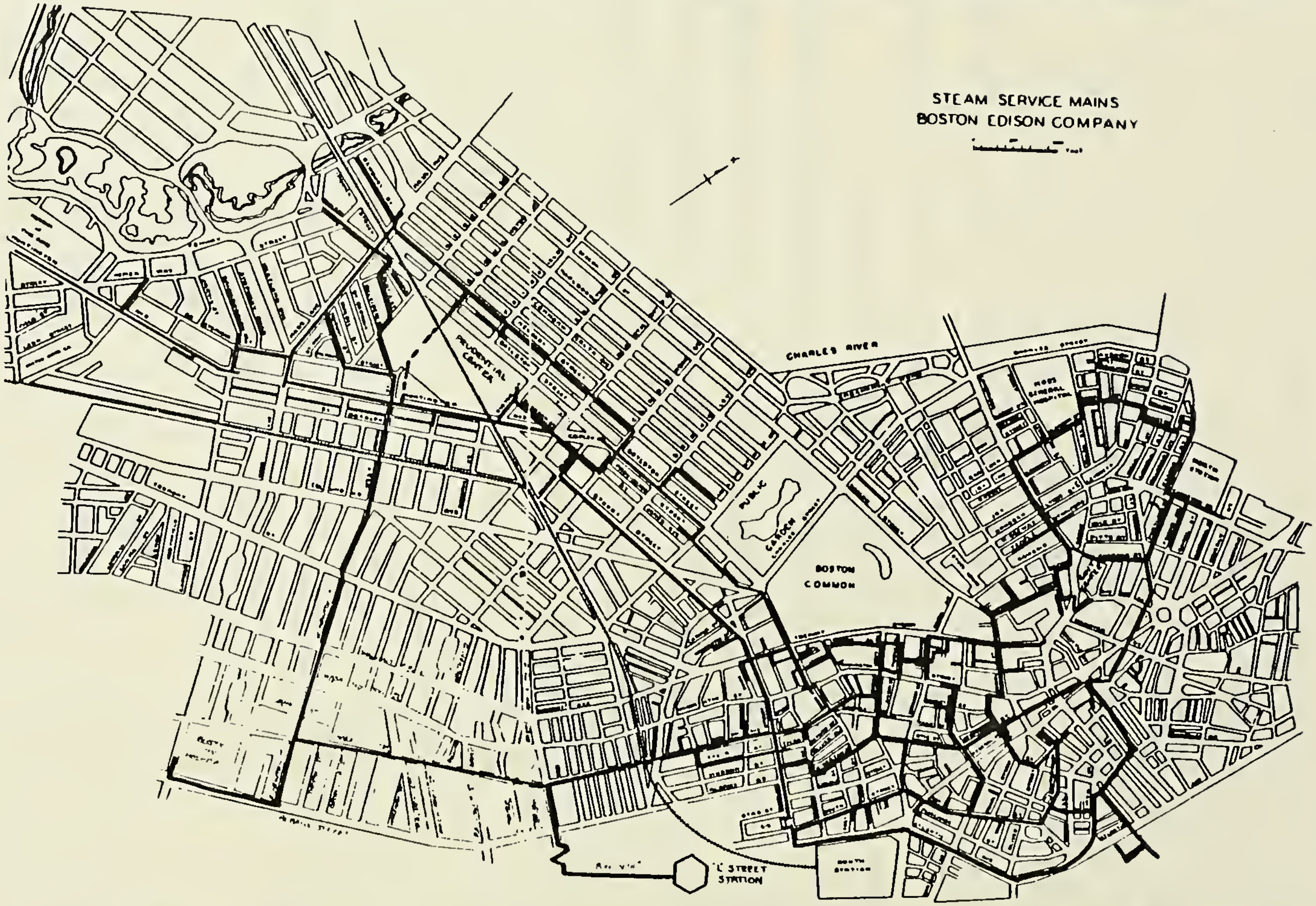
* Generally 250 psig at dry saturation, but pressure varies depending on the needs of the system.

Figure 1 Plan of Boston Edison District Heating System (updated to November 1980)



Source: Boston Edison Company, "Steam Service Installations; Information and Requirements" (September 1971)

Policies

II. BOSTON REDEVELOPMENT AUTHORITY'S NEW ENERGY POLICIES

A. Technology Review and Evaluation

The SAND work plan began with the formation of an interdisciplinary advisory committee consisting of representatives from the BRA, the Boston Zoning Commission, the electric and gas utilities, and the architectural, engineering, and development communities. That committee met monthly for seven months to review Boston's technological options and help articulate the policies implied by the conclusions reached. The technological review was based on a literature search conducted for the BRA by MITRE Corporation[5] and resulted in a list of policies related to the technologies reviewed. Table 1 shows the policy results of the committee work and the evaluation process those policies underwent.

Over the ensuing twelve months, the policies from Table 1 which received favorable ratings were applied to or analyzed in the context of a wide variety of test cases. This further analysis resulted in substantial refinement of the policies discussed by the advisory committee into their current form, reported below. Contributing to this analysis, a number of events took place which further shaped the outcome of these policies. Those events included:

1) the price of natural gas in the Northeast rose to parity with the price of oil;
2) Boston's natural gas utility reached near capacity utilization;
3) the world-wide recession and energy conservation efforts reduced oil demand and the resulting oil glut reduced oil prices;
4) Boston's electric utility cancelled plans for a 1100 MW nuclear plant and further planning of a hydro-electric facility;

5) there were dramatic strides forward in a number of energy technologies, particularly load management technologies employing microprocessors.

These events forced the realization that, given the rapid pace at which technologies are advancing and the economics of energy are changing, Boston's energy policies must be broadly stated to allow city agencies and private developers to respond to changing marketplace and regulatory conditions and to judge each development project according to its own specific circumstances. The BRA, as a city planning and development agency, lacks the technical capabilties to understand different technologies or track their progress to the degree necessary to actively promote one over another. As a public agency, for example, it could not require responsibly that a developer install an energy system which it could not predict with relative certainty would remain cost competitive and certain of fuel supply. The importance of this perception should be underscored.

Absent adequate technical skills, the BRA must rely ultimately on private developers or independent analysts to determine what design or type of energy system makes best economic sense for their projects after the BRA has provided incentives for the use of designs and systems which conserve fossil fuels, required investigations of options, and satisfied itself that, given a project's circumstances, a reasonable choice of design and systems has been made from the perspective of both the developer and the City. This approach to policy formulation avoided the creation of policies which would result in inappropriate intervention by the BRA in technical matters in the future and allowed SAND staff to work towards the development of policies and institutional tools which would survive erratic economies and changing fuel supply scenarios.

Policy Options	Regulation Type	Approach	Energy Efficiency	Development Impact	Economic Impact	Government Cost	Political Feasibility	Environmental Impact	Utility Impact	Rank	Comments
CONSERVATION OPPORTUNITIES											
1. Encourage and facilitate the redevelopment of buildings and sites which are currently served by utility and transportation systems.	PDA 121A UR	I I C	+	+	+	+	+	+	+	+7	This is a logical and easily implemented policy. Land values, marketability, and historic preservation sentiments favor it, as do others members of the planning staff at BRA and local political interests.
2. Maximize development options at key locations on major transportation routes, especially those with public transit service.	PDA 121A UR	I I C	+	+	+	+	+	+	+	+7	Should be amended to read "consistent with other devlopment policies". As written, the policy is too broad and could result in inappropriate land uses in some cases. Also, optimal level of development must be determined.
3. Provide incentives for individual metering in multi-family housing proposed under the PDA or 121A programs.	PDA 121A UR	I I C	+	+	+	+	+	+	+	+7	This policy has been shown by the utility to result in conservation. The utility supports it wholeheartedly, as does the private sector.
4. Provide incentives, such as FAR bonuses, to developers seeking BRA design approval who incorporate into their building designs certain energy conserving or producing technologies, including solar systems, water conserving devices, lighting, efficient design, cogeneration, recycling systems, high efficiency heating and cooling plants, reduced proportion of outside surface to interior space, and others.	PDA 121A UR	I I C	+	+	+	0	+	+	+	+6	The utilities expressed strong concern that this policy or any other not unduely bias the developer's choice of energy supply. The city maintains that some bias may be necessary at times to encourage energy choices in the long term interest of the city which might not be made in a free market context. Incentive approach backfired in NYC; performance zoning should be considered. Life cycle costing should reveal best choices and appropriate amounts of bonuses.
5. Provide incentives to developers who incorporate energy conserving features into site plans, including solar, wind, and shading considerations.	PDA 121A UR	I I C	+	+	+	0	+	+	+	+6	See #4.

Policy Options	Regulation Type	Approach	Energy Efficiency	Development Impact	Economic Impact	Government Cost	Political Feasibility	Environmental Impact	Utility Impact	Rank	Comments
6. Require life cycle costing of special development projects (SDPs).	PDA 121A UR	M M C	+	0	+	—	+	+	+	+4	Parameters need defining. Computer program probably needed. Source of funds for computer program and BRA staff uncertain.
7. Require SDP developers to include data on embodied energy in existing structures in their BRA applications.	PDA 121A UR	M M C	+	—	0	—	—	+	0	-1	Savings inconsequential relative to effort required. Preservationist feeling and current aesthetic inclines market toward rehab anyway.
8. Require SDP developers to include data on embodied energy in their proposed building materials and processes as part of their BRA applications.	PDA 121A UR	M M C	+	—	0	—	—	+	0	-1	Include in Life Cycle Costing process.
9. Provide incentives to SDP developers who limit, to the extent possible, the hours of operation of their facilites.	PDA 121A UR	I I C	+	—	0	0	—	0	0	-1	Politically unacceptable. Also, unless employers are changing to 4-day weeks, this policy would create transportation problems and cut jobs.
10. Provide incentives to SDP developers for meeting building energy performance standards.	PDA 121A UR	I I C	+	0	+	+	0	+	+	+5	Standards proposed by DOE unacceptable to the utility. Include in Life Cycle Costing process.
11. Provide incentives to SDP developers who proposed mixed use projects.	PDA 121A UR	I I C	+	+	+	0	+	+	+	+6	Type of mix needs to be regulated from an energy point of view

	Policy Options	Regulation Type	Approach	Energy Efficiency	Development Impact	Economic Impact	Government Cost	Political Feasibility	Environmental Impact	Utility Impact	Rank	Comments
12.	Provide incentives for SDP developers who provide priority parking facilities and other incentives for energy efficient modes of transportation, such as car and van pools, compact car parking spaces, safe bicycle racks,, mini-bus service, etc.	PDA 121A UR	I I C	+	+	0	+	+	+	+	+6	No opposition. Focus on providing special parking for compact cars because of Boston's high percentage thereof.
13.	Encourage the creation of bikeways and walkways in SDPs by providing incentives to developers.	PDA 121A UR	I I C	+	+	0	+	+	+	0	+4	Of marginal concern. More appropriate for new subdivisions. Difficult to implement in dense urban areas. Walking already a dominate mode of transportation, as is biking.
14.	Encourage urban infilling in PDAs and URAs.	PDA 121A UR	I I C	+	+	+	+	+	—	0	+4	Market already does so. Little opportunity in residential areas. Occurs in the form of major development in inner city.
15.	Promote the conservation and production of energy by providing training to key BRA staff in subjects which will better equip them to assess energy analyses and designs.	PDA 121A UR	O O O	+	+	+	—	+	+	+	+5	Government cost is a serious problem today. Might be funded out of new permit fees.
16.	Promote the incorporation of energy conservation and production, design features and technologies into SDP plans by providing developers with a set of guidelines covering these areas.	PDA 121A UR	I I I	+	+	+	—	+	+	+	+5	Delete "set of guidelines" and insert "technical assistance and/or information". Again, government cost a difficult problem.
17.	Modify Zoning Code to permit building shapes and volumes which conserve energy by reducing exposed surfaces and building envelope materials requirements.	BZC	D	+	+	+	+		+	+	+5	This policy might encounter strong resistance from the neighborhoods affected.

Policy Options	Regulation Type	Approach	Energy Efficiency	Development Impact	Economic Impact	Government Cost	Political Feasibility	Environmental Impact	Utility Impact	Rank	Comments
18. Modify Zoning Code to permit increased densities in districts which are in close proximity to public transportation, retail, and employment centers.	BZC	D	+	+	+	+	0	+	0	+5	
19. Amend Zoning Code to classify certain commercial uses as conditional uses in residential districts.	BZC	D	+	+	+	+	+	+	+	+7	Some felt this policy is politically infeasible. Others felt, if carefully done, it would be acceptable. Others felt it would result in no or a negative energy savings.
20. Amend Zoning Code to remove restrictions on overhangs and other shading devices.	BZC	D	+	+	+	+	+	+	+	+7	Some restrictions need to be built in for special cases.
21. Modify the Zoning Code to allow maximum possible siting flexibility for new residential construction.	BZC	D	0	0	0	0	0	0	0	0	Incidence of new residential construction so small as to offer almost no opportunities. What new construction there is is severely limited by other siting considerations.
22. Amend the Zoning Code to permit urban infilling where appropriate.	BZC	D									See #14.

Policy Options	Regulation Type	Approach	Energy Efficiency	Development Impact	Economic Impact	Government Cost	Political Feasibility	Environmental Impact	Utility Impact	Rank	Comments
SUPPLY OPPORTUNITIES											
23. Promote the use of cogeneration plants, particularly gas-fueled plants, by providing incentives to SDP developers, such as FAR bonuses, and encouraging large developments.	PDA 121A UR	I I C	+	0	—	—	0	0	0	-1	The committee will not endorse the promotion of a single technology. A more general approa which awards bonuses for the conservation or efficient production of energy by any means or via any technology is needed.
24. Promote the creation of integrated energy systems in planned developments by providing incentives to developers, such as FAR bonuses.	PDA 121A UR	I I C	+	+	+	—	+	0	+	+5	There are many questions about how this would be done: how would developer's respond; how much government staff time would be required; what are the environmental impacts? A more general approach is preferred, such as life cycle costing.
25. Promote increased use of Boston's district heating system by providing incentives, such as FAR bonuses, to developers who propose to utilize the system.	PDA 121A UR	I I C	—	—	—	0	—	—	—	-6	Unless the district heating system changes over to solid waste or some other fuel source, it should not be actively promoted, given its inefficiency.
26. Promote solid waste recovery by providing incentives to developers, industries or utilities.	PDA 121A UR	I I C	+	0	0	—	0	+	0	+1	Inappropriate for SAND.
27. Promote production of wind generated electricity by providing incentives, such as FAR bonuses, to developers or industries.	PDA 121A UR	I I C	—	0	—	—	—	—	—	-6	Flat rejection by committee. Boston's electri utility currently has excess reserves available.

Policy Options	Regulation Type	Approach	Energy Efficiency	Development Impact	Economic Impact	Government Cost	Political Feasibility	Environmental Impact	Utility Impact	Rank	Comments
28. Amend the Zoning Code to define solar collectors, electricity producing windmills and accessory equipment, cogeneration equipment, and any other energy producing equipment as a non-accessory use, thereby freeing such equipment from Code restrictions.	BZC	D	+	+	+	+	+	+	+	+7	This is a simple matter which will help reduce uncertainties in this area.
29. Amend the Zoning Code to exempt solar collectors, greenhouses, air-lock porches, overhangs and other passive solar additions from setback, lot coverage and other restrictions.	BZC	D	+	+	+	+	+	+	+	+7	This policy needs work to protect neighbors from solar additions which are too large or unsightly.
30. Amend the Zoning Code to increase densities on south-facing slopes in residential districts.	BZC	D	+	+	+	+	—	+	+	+5	Economic and physical constraints make it highly unlikely that such an amendment would result in increased building in neighborhoods which are already developed (all in Boston).
31. Amend the Zoning Code to establish height limits in certain single family residential districts in order to protect existing solar access, with an exemption for additions to building height, the shadows of which do not encroach upon adjacent lots above eight feet on the vertical plane of any adjacent lot's lot line between 9 a.m. and 3 p.m. on December 21.	BZC	M	+	0	+	+	0	+	+	+5	The committee favors the concept but desires that more work be done on the phrasing of the policy.
32. Amend the Zoning Code to exempt solar collectors of any type, including active and passive, from height restrictions, provided they do not encroach upon the solar access of another lot as defined in policy option number 31.	BZC	D									See #31.

Policy Options	Regulation Type	Approach	Energy Efficiency	Development Impact	Economic Impact	Government Cost	Political Feasibility	Environmental Impact	Utility Impact	Rank	Comments
33. Amend the Zoning Code to define solar collectors as any device or structure whose primary purpose is to convert sunlight into thermal or electrical energy.	BZC	0	+	+	+	+	+	+	+	+7	This, also, is a simple matter which will reduce uncertainty in this area.
34. Amend the Zoning Code to require site design review by the BRA when vegetation on one lot limits solar access, as defined in policy option #31, on another lot.	BZC	0	0	0	0	–	–	0	0	-1	Given that this proposal would be politically unpopular, the BRA does not have the staff, and this would be an unusual and appropriate role for the BRA to play, the committee rejected this policy, left it for legislaure or courts.
35. Amend the Zoning Code to permit maximum siting flexibility for new construction.	BZC	D									See #21. Larger developments due not encounter the Zoning Code as a significant impediment.
36. Amend the Zoning Code to provide FAR bonuses to builders who propose to make maximum feasible use of solar, wind, super insulation, cogeneration or district heating.	BZC	I									Not liking the approach of this policy, the one below was proposed.
If a developer takes measures which are not cost effective during his projected period of involvement, but are over the life of the development, provide certain incentives to the developer.			+	+	+	–	+	+	0	+4	When tied to life cycle costing, this policy would provide the kind of generalized, flexible framework necessary to accomodate the wide variety of development proposals and energy technologies which the future will bring.

B. Energy Policies

The BRA is responsible for assuring to the best of its ability that the present and future citizens of Boston will enjoy development which is and will remain economically sound, functional, environmentally beneficial, and aesthetically pleasing. It is not in the business of designing energy systems. Therefore, BRA policies, while they do indicate clear preferences for certain kinds of energy systems, do not favor particular energy systems since there will be inevitable uncertainty and controversy at a given moment over which systems are best for a given application.

The BRA's policy on energy use and building design is to support the design and construction of buildings and the installation and use of energy systems in Boston which:

1. Require as little operating energy as possible and, particularly, consume as little fossil fuel as possible (including fossil fuel-derived electricity);
2. Help to improve the efficiency (reduce the peaks) of the electric and gas utilities;
3. Do not cause neighboring buildings to consume more fossil fuel than they would have otherwise;
4. Support the local economy through the purchase of local equipment and supplies rather than foreign fuels (e.g., we prefer to see a dollar spent on solar collector maintenance than on oil);
5. Help to minimize the consumption of transportation fuels;
6. Are reliable and, if possible, flexible in terms of fuel sources; and
7. Minimize adverse environmental impacts on Boston's residents.

Implementation Strategies - Generally

1. Require careful consideration of building orientation and massing and fenestration options, particularly with regard to cooling loads.
2. Require extensive landscaping designed, particularly, to reduce cooling loads.
3. Require wind tunnel testing for massive or high-rise development proposals.
4. Require life cycle costing of building design and system options.
5. Support the use of renewable energy systems over those which consume fossil fuels, even where life cycle cost analysis show them to be marginally economical.
6. Support the use of high efficiency energy systems, such as heat pumps, daily or seasonal storage systems, or, where appropriate, cogeneration.
7. Support the installation of highly efficient multi-building systems, such as district heating and/or cooling systems, electronic load shedding systems, or cogeneration systems.
8. Support the installation of systems such as those above despite their higher capital costs, particularly if capital and maintenance costs are to be spent locally.
9. Support the installation of energy systems which have the smallest possible adverse environmental impact, particularly in high density areas.

Targetted Areas of Concern

Since more than half of the energy consumed by buildings in Boston (56.6%) is used in the commercial sector, the Authority will look first toward the commercial sector for the conservation of electric energy and cooperation in working to level the Boston Edison Company (BECo) load profile. The major consumers in this sector are hospitals, schools, colleges, and offices in the finance, insurance and real estate sectors.

In the commercial and municipal sectors, lighting and cooling are of particular concern because of their contribution to BECo's annual and summer peak. While cooling uses less total energy because of the short cooling season, it is responsible for the largest demand peak and, therefore, results in increased capital and operating costs for the electric utility and higher demand charges, including a special summer surcharge, for consumers. Lighting is really a double load since heat produced by lights must be removed by cooling systems. The design and construction of systems which mitigate this effect are encouraged.

In the residential sector, the largest amounts of energy are needed for space heating purposes which is an important priority, but one which the BRA can do less about because it reviews less of this type of development. Nevertheless, it will be an important priority where the BRA is involved.

Some Examples

As of this writing, most new development in Boston is being designed with all electric space heating, cooling, and hot water systems for a variety of reasons, but principally because of lower capital costs. Where fossil fuel systems must be installed, the Authority is concerned with the net efficiency of the systems proposed, as measured from fuel input to useful energy output. Thus, while electric resistance heating with an efficiency of .33 (as measured from primary fuel to the wall socket) is not desirable, heat pumps, with a net efficiency of 1 or better (heat pump unit efficiency of 3 or better) would be highly desirable at this time, particularly if designed in conjunction with a daily storage system which would permit much heating and cooling to be done during BECo's off-peak hours, when electricity is being produced by BECo's most efficient power plants.

BECo's summer peak could be reduced by 10% if merely 2 million square feet of existing office space had thermal storage capacity and could avoid running chillers during peak hours. The new State Transportation Building at Park Square and the Exchange Place tower at State and Congress Streets, with combined square footages of approximately 1.4 million, for example, will both use thermal storage/heat pump systems, operating on negotiated BECo time-of-use rates to minimize demand charges and reduce consumption.

The Transportation Building (400,000 square feet) will demand less than 65,000 Btus/ft^2/yr at the building wall, an admirable accomplishment partly achieved by a design which minimizes summer solar gain and captures waste heat. (Although prepared to tie into the BECo district steam system if necessary, this building was designed and built without a back-up heating system, relying on internally generated heat as its primary heat source.)

The new GSA building, to be built at North Station, is expected to demand under 50,000 Btu/ft^2/yr, less than ¼ of the demand of the average office building in Boston in 1978. These buildings have set new standards for energy efficiency and systems in Boston and are models for future development here.

III. ZONING

At the time SAND began, there was no mention of energy in the Boston Zoning Code. Its effect on energy planning and systems was, like that of other regulations, random. After completing the technology review and policy analysis processes, a set of additions to and modifications of the Zoning Code, intended to implement the policies where possible, was developed. See Table 1, numbers 17-22 and 28-36. These proposals were modified several times before arriving at the final set, presented, with noted exceptions, below.

Four packages of changes to be recommended for the Boston Zoning Code were developed, one each for procedural matters, cluster zoning, energy efficiency bonuses, and solar provisions. Article 20 of the State Building Code, referred to in the energy efficiency provisions, is attached as Appendix A for reference.

This draft of proposed zoning code changes was gradually scaled back in scope after review by persons more sensitive to the political feasibility of such proposals. For example, the F.A.R. bonus system based on the Energy Efficiency Ratio definition was removed because there was a strong sense that the provision of additional leverage for developers in negotiations over F.A.R. would be undesirable given the immense pressure now being felt in Boston to drastically increase densities in certain areas of the City. Also, more restrictive solar access protection, even when confined to single family districts was thought to create too many potential legal and administrative problems for the uncertain benefit created, and was rejected by senior administrators.

A. Procedural Issues

The first set of proposals includes the promotion of energy conservation in the "Purpose" section (§1-2), a requirement of energy information from PDA applicants (§3-1A), the establishment of grounds for a zoning variance appeal based on energy conservation needs (§7-2), and establishment of authority for the Board of Appeal to condition variances on the conservation of energy in some appropriate manner (§§6-4 and 7-4).

1. By inserting into Section 1-2, a new purpose, as follows:

> SECTION 1-2. Purpose. The purposes of this code are hereby declared to be: to promote the health, safety, convenience, morals and welfare of the inhabitants of the City; to encourage the most appropriate use of land throughout the City; to prevent overcrowding of land; to conserve the value of land and buildings; to lessen congestion in the streets; to avoid undue concentration of population; to provide adequate light and air; to secure safety from fire, panic and other dangers; to facilitate adequate provision for transportation, water, sewerage, schools, parks and other public requirements; to preserve the economic and environmental well-being of the City by the conservation of fossil fuel derived energy; and to preserve and increase the amenities of the City.

2. By inserting new language into the paragraph of Section 3-1A as follows:

> 3-1A. Special Purpose Overlay Districts. . . . .
>
> Planned Development Areas. The whole or any part of a subdistrict may be established as a planned development area if such area contains not less than one acre and the commission has received from the Boston Redevelopment Authority a development plan, approved by said Authority after a public hearing, for the development of the planned development area, singly or in connection with other planned development areas, provided, however, that no development plan shall be approved by said Authority unless said Authority finds that such plan conforms to the general plan for the City as a whole and that nothing in such plan will be injurious to the neighborhood or otherwise detrimental to the public welfare. Such development plan shall set forth the proposed location, solar orientation, and appearance of structures, open spaces and landscaping, including shade patterns produced by buildings and natural features at the solstices and equinoxes within and without the proposed area, proposed uses of the area, densities, proposed traffic circulation, parking, and loading facilities, public utility infrastructure layout, access to public transportation, proposed dimensions of structures, proposed energy systems, and may include proposed building materials, and such other matters as said Authority deems appropriate to its consideration of the proposed development of the area.

3. By inserting into Section 7-2, new language, as follows:

> SECTION 7-2. Procedure For Appeal. Each appeal for a variance shall be filed in quadruplicate with the Building Commissioner, who shall retain one copy for his files and transmit the other copies as follows: one to the Board of Appeal, one to the Boston Redevelopment Authority, and the other to the Zoning Commssion.
>
> In each of the following cases, the Boston Redevelopment Authority shall, within thirty days after the date of such transmittal, file with the Board of Appeal a report with recommendations, together with material, maps or plans to aid the Board of Appeal in judging the appeal and determining special limitations and safeguards:
>
> . . .
> (c) . . . ; (and)
> (d) . . . (.) ;
> (e) an appeal for a variance in any portion of this Code for the purpose of conserving fossil fuel derived energy.

4. By inserting into Sections 6-4 and 7-4 new language, as follows:

> SECTION 6-4. Other Conditions Necessary As Protection. and
>
> SECTION 7-4. Other Conditions Necessary As Protection. In approving a conditional use/variance, the Board of Appeal may attach such conditions and safeguards as it deems necessary to assure harmony with the general purposes and intent of this code, such as, but not limited to, the following:
>
> . . . .
> (f) . . . ; and
> (g) a requirement to make provisions for the conservation of fossil fuel derived energy, such as a requirement that applicant obtain time of day rates for its electric supply, or not interfere with the solar access of another lot.

B. Floor Area Ratio Bonuses

The following proposals, no longer under consideration, would have created F.A.R. bonuses for structures which were more energy efficient than if they had been designed to the minimum standards set out in the State Building Code (Appendix A). Section 2013 of the State Building Code sets out a methodology and requirements for documentation which would have been required to be certified by a registered engineer or architect and accepted as complete and accurate by the City Building Department before an F.A.R. bonus could have been calculated or granted. All procedures conform to ASHRAE and industry standards.

The bonuses would have been greater for structures built in low F.A.R. districts and with higher energy efficiency in order to compensate builders for additional administrative and capital costs, avoid undue benefit to builders in high F.A.R. districts, and to reward the efficient. Resting on the definitions of "Energy Demand" and "Energy Efficiency Rating", the bonus structure was intended to encourage such energy conservation strategies as super-insulation, solar, and high-efficiency heat pumps.

The last proposal, still viable, simply acknowledges the 60% penetration of compact cars in the Greater Boston Area market, and will allow smaller parking lots in the Parking Freeze District to accomodate the same number of cars larger lots now do, or allow existing lots not in the Parking Freeze Overlay District to accomodate more cars per acre.

1. By inserting into Section 2-1 the following new definitions:

(16A) "Energy demand", the number of British thermal units of energy a building will require of a system, including the electric utility, which burns or causes to be burned fossil fuels during a calendar year to meet the minimum design standards of the Massachusetts State Building Code for heating, cooling, lighting, and mechanical system needs.

(16B) "Energy efficiency rating", the ratio of projected building energy demand, as calculated per the procedures specified in Section 2013 and related sections of Article 20 of the Massachusetts State Building Code, before and after energy conservation motivated design modifications. An Energy Efficiency Rating (EER) of .5, for example, indicates that the alternative design's projected demand for fossil fuel derived energy is one-half that projected for the standard design (i.e., for the same building without, for example, special south-facing glazing, super-insulation, thermal storage systems, etc.).

$$\text{EER} = \frac{\text{Fossil fuel consumption of alternative design}}{\text{Fossil fuel consumption of standard design}}$$

(16C) "Energy efficient", a building which has an Energy Efficiency Rating of one (1) or less.

2. By inserting into Article 15 below Section 15-6, the following new Section 15-7:

SECTION 15-7. Special Floor Area Ratio Provision For Energy Efficient Projects. A building which can be certified by a registered engineer using the procedures set forth in Section 2013 or 2014 of Article 20 of the State Building Code, to be energy efficient, as defined in this Code, shall be allowed an F.A.R. bonus according to Table C below. A building which is to be located within 1500 feet walking distance of an active Massachusetts Bay Transit Authority stop shall be deemed to have an EER of .90 or its actual EER as calculated above, whichever is less.

Table C

Current F.A.R.	EER*	Bonus	EER*	Bonus	EER*	Bonus
Less than 1:	0 to .5	33%	.51 to .75	20%	.76 to 1	10%
More than 1, less than 5:	0 to .5	20%	.51 to .75	10%	.76 to 1	5%
5 or more:	0 to .5	10%	.51 to .75	5%	.76 to 1	2.5%

* Energy Efficiency Rating; see Section 2-1. Meaning of Certain Words and Phrases.

3. By amending Section 23-9 by reducing the required length of off-street parking spaces from twenty to eighteen feet, as follows:

SECTION 23-9. Design. All off-street parking facilities provided to comply with this Article shall meet the following specifications:

. . . .

(d) Each car space shall be located entirely on the lot and shall be no less than eight and one half feet in width and (twenty) eighteen feet in length, exlusive of maneuvering areas and access drives.

C. Cluster Zoning

It is proposed that cluster development become an allowed land use and planning development tool in the City of Boston for the following reasons:

- Commonwall housing is approximately 40% more energy efficient than single family housing and would, presumably, be the most frequently chosen type of housing by developers contemplating cluster development.

- Clustering facilitates the use of landscaping as a significant conservation strategy.
- Zoning flexibility facilitates solar orientation of the housing and solar access protection.
- Clustering allows for consideration of cost-effective community-wide energy systems.

1. By inserting, below Use Item No. 7B in Table A of Section 8-7, respecting use regulations, a new heading and use item as follows:

	CLUSTER DEVELOPMENT**	S	R	H	C	B	I	M	U
7C.	Cluster Development, provided that the Board of Appeal finds (1) that the development is designed to protect solar access to dwellings within and adjacent to the development parcel; and (2) that there will be greater utilization of energy conservation measures and/or that the quantity or quality of open space will be greater than would be feasible without such clustering. * Provided also that in an S district, housing types are limited to those listed under Use Item Numbers 1 though 3 inclusive and that in an R-.5 district, housing types are limited to those listed under Use Items Numbers 1 through 6 inclusive.	C*	C*	C	C	C	F	F	F

** Districts: S=Single family; R=Multifamily; H=Apartment; C=Commercial; B=Business; I=Industrial; M=Manufacturing; U=Waterfront.

2. By inserting into Article 13, respecting dimensional requirements, the following new section:

SECTION 13-6. Cluster Developments. In a cluster development all dimensional requirements of Table B of Section 13-1 and of Articles 14 through 22, other than Sections 14-5 and 22-4, shall apply, but they shall apply as if the development parcel were a single lot even though such parcel is subdivided or to be subdivided into smaller lots.

3. By inserting into Article 17, respecting open space requirements for residences, the following new section:

   SECTION 17-3. Special Provisions for Cluster Development. In a cluster development, open land not subdivided to individual dwelling units shall be conveyed to a corporation or trust owned or to be owned by the owners of lots or dwelling units within such cluster development parcel, or conveyed to and accepted by the city for park or open space purposes or conveyed to and accepted by the Boston Conservation Commission.

4. By inserting at the end of Section 23-8(a), respecting the location of off-street parking facilities, the following new sentence:

   For purposes of this section and Section 23-9, paragraph (d), a cluster development parcel (Use Item No. 7C) shall be considered a single lot whether or not subdivided into smaller lots.

D. Solar

That Boston is not an ideal location for solar installations does not mean solar should or will not be an important part of New England's future fuel mix. The Boston Zoning Code should explicitly encourage solar building designs in Boston and be ready when the building and banking industries and Boston's housing consumers begin to demand more solar construction. These proposals are not all that can be done. They are merely one preliminary, though important, step. Further regulation of solar access and use will have to await a time when there is more information on use of solar technology and constituent expectations, and clearer City policies on the subject.

1. By inserting into Section 2-1, the following new definitions and amendment to the definition of "Floor area, gross":

   (16A) "Energy demand", the number of British thermal units of energy a building will require of a system, including the electric utility, which burns or causes to be burned fossil fuels during a calendar year to meet the minimum design standards of the Massachusetts State Building Code for heating, cooling, lighting, and mechanical system needs.

(16B) "Energy efficiency rating", the ratio of projected building energy demand, as calculated per the procedures specified in Section 2013 and related sections of Article 20 of the Massachusetts State Building Code, before and after energy conservation motivated design modifications. An Energy Efficiency Rating (EER) of .5, for example, indicates that the alternative design's projected demand for fossil fuel derived energy is one-half that projected for the standard design (i.e., for the same building without, for example, special south-facing glazing, super-insulation, thermal storage systems, etc.).

$$\text{EER} = \frac{\text{Fossil fuel consumption of alternative design}}{\text{Fossil fuel consumption of standard design}}$$

(16C) "Energy efficient", a building which has an Energy Efficiency Rating of one (1) or less.

(21) "Floor area, gross", the sum of areas of the several floors of the structure, as measured by the exterior faces of the walls, including fully enclosed porches and the like as measured by the exterior limits thereof, but excluding (a) garage space which is in the basement of a building or, in the case of garage space accessory to a dwelling, is at grade, (b) basement and cellar areas devoted exclusively to use accessory to the operation of the structure and (c) area elsewhere in the structure devoted to housing mechanical equipment customarily located in the basement or cellar such as heating and air conditioning equipment, thermal storage mass, electrical equipment, laundry facilities and storage facilities, provided, however, that in an H-2-65, L-2-65, B-3-65 or H-3-65 district no area in an existing structure previously included in gross floor area and no area in any addition to an existing structure, except areas not used or designed to be used for human occupancy, such as attics, basements, cellars or space under sloping eaves, shall be excludable from gross floor area as area for storage facilities or laundry facilities.

(41H) "Solar access", (1) unobstructed access to direct sunlight from any point on a building's rooftop or exterior walls or (2) such unobstructed access to direct sunlight as exists for a given lot on the date on which this definition is enacted, whichever is less.

(41I) "Solar orientation", the orientation of a building or portion of a building such that its longest axis is east to west (90° from true south) with acceptable variations of 10° to the northwest and 25° to the southwest or that the side of the building with the greatest percentage of wall area devoted to the collection of solar energy faces true south with acceptable variations of 10° to the southwest and 25° to the southeast. (See Diagram.)

(41J) "Solar collector", a device or combination of devices, structures or parts of a device or structure that require access to sunlight in order to transform solar energy into thermal, mechanical, chemical, or electrical energy that will contribute significantly to a structure's energy supply.

(46A) "Sunspace", a structure, which may or may not be habitable, the primary purpose of which is the collection and/or storage of thermal energy from sunlight for use by building occupants. As such, a sunspace shall

(a) have a solar orientation as defined in this Code, and
(b) have solar access as defined in this Code from 9:00 a.m. to 3:00 p.m. Eastern Standard Time and calculated as if on December 21.

2. By inserting into Section 10-1, new language, as follows:

SECTION 10-1. Limitation of Area. The accessory uses on a lot, exclusive of off-street parking, solar collectors, and sunspaces, shall not occupy in the aggregate more than twenty-five percent of the floor area of the main buildings; nor shall the accessory uses on a lot, exclusive of off-street parking required by this code, solar collectors, and sunspaces, occupy, in the aggregate, more than twenty-five percent of the rear yard required by this code or of the unbuilt lot area; nor in any residential district shall any accessory use occupy any part of the front or side yards required by this code, except that such a side yard may be used for off-street parking , solar collectors, and sunspaces located more than five feet from the side lot line; and in no other district shall any accessory use other than off-street parking and sun spaces occupy any part of the front or side yards required by this code.

3. By inserting into Article 14, respecting lot size, area, and width, a new section 14-7, as follows:

SECTION 14-7. Solar Access. No structure shall be erected in any S district which obstructs the solar access of any solar collector or sunspace whose installation has been approved by the Boston Redevelopment Authority and which has been installed in conformance with any conditions imposed by the Authority pursuant to design review.

4. By inserting into Section 16-2, new language, as follows:

SECTION 16-2. Exceptions. The provisions of Section 16-1 shall not apply to belfries, cupolas, domes, monuments, church spires, water towers, smokestacks, silos, derricks, conveyors, masts, flag poles, aerials, elevator headhouses, water tanks, monitors, signs, solar collectors or other structures normally built above the roof and not devoted to human occupancy, but such structures shall be erected only to such heights, and cover only such areas as are necessary to accomplish the purpose they are intended to serve.

5. By inserting into Section 18-5, new language, as follows:

SECTION 18-5. Front Wall of Building Not Parallel to Front Lot Line. If the front wall of a building is not parallel to the front lot line, but the average distance between such wall and such lot line is no less than the minimum front yard depth otherwise required by this Article, and the distance between such wall and such lot line is at no point less than three fourths of the minimum front yard depth so otherwise required, and in the case of a building which requires solar orientation in order to achieve an energy efficiency rating of between 0 and .75, the requirements of this Article shall be deemed to be met.

6. By inserting into Section 19-1, new language, as follows:

SECTION 19-1. Side Yard Requirements. Except as otherwise provided in this Article, where a minimum width of side yard is specified in Table B of Section 13-1, so much of every lot within the district, and devoted to the use, specified as lies between the lot line on one side of such lot and a line inside the lot parallel to, and such minimum width from such lot line, and also so much of every such lot as lies between the lot line on the other side of such lot and a line inside the lot parallel to, and such minimum width from, such lot line, are hereby required as side yards within which no planting other than shade trees shall be maintained more than six feet above the average natural grade in such yard and within which no structure shall be erected except:

. . . .

, (g) shade overhangs of reasonable dimensions if not coming within three feet of any side lot line and not extending more than three and one half feet into the side yard, and (h) sunspaces or solar collectors.

7. By inserting into Section 19-7, new language, as follows:

SECTION 19-7. Side Wall of Building Not Parallel to Side Lot Line. If the side wall of a building is not parallel to the side lot line nearest to it, but the average distance between such wall and such lot line is no less than the minimum side yard width otherwise required by this Article, and the distance between such wall and such lot line is at no point less, in the case of a side lot line which is not also a street line, than three-fourths of the minimum side yard width so otherwise required, and in the case of a side lot line which is also a street line, than one-half of the minimum side yard width so otherwise required, and in the case of a building which requires solar orientation in order to achieve an energy efficiency rating of between 0 and .75, the requirements of this Article shall be deemed to be met.

8. By inserting into Section 20-6, new language, as follows:

SECTION 20-6. Rear Wall of Building Not Parallel to Rear Lot Line. If the rear wall of a building is not parallel to the rear lot line and the rear lot line is not also a street line, but the average distance between such wall and such lot line is no less than the minimum rear yard depth otherwise required by this Article, and the distance between such wall and such lot line is at no point less, in the case of a side lot line which is not also a street line, than three-fourths of the minimum rear yard depth so otherwise required, or, in the case of a building which requires solar orientation in order to achieve an energy efficiency rating of between 0 and .75, the requirements of this Article shall be deemed to be met.

Development review

IV. DEVELOPMENT REVIEW

The Boston Redevelopment Authority (BRA) is a corporation created under Massachusetts General Laws, Chapter 121B, for the prupose of overseeing and administering the processes and funds necessary to accomplish redevelopment throughout the city of Boston, principally in urban renewal areas. Although it is a separate legal entity from the City of Boston, its functions are intimately intertwined with those of many City offices and its budget is approved by Boston's nine-member City Council and Mayor. The BRA serves a number of functions for the City of Boston, including the following:

1. Planning, designation, and development of Urban Renewal Areas (URAs);
2. Planning, designation, and development of Commercial Area Revitalization Areas (CARDs);
3. Advising the Zoning Board of Appeals, making recommendations on applications for variances, Planned Developments Area (PDA) designation, or other deviation from the Zoning Code;
4. Disposing of City-owned property; and
5. Negotiating tax agreements (121As) for subsidized housing.

The type and degree of review which a development will receive will depend upon which of the channels through which it comes to the Authority. Most development proposals are reviewed with regard to the following concerns:

1. Financials: are the assumptions on which the developer is operating reasonable and workable enough so that the development will be able to operate at a profit and pay its taxes?
2. Zoning: does the proposal comply with the Zoning Code?

3. Design: does the design comport with urban design guidelines established for the City and/or its particular site?
4. Legal: are the City's interests adequately protected?
5. Amenities: in an era of reduced public spending, what public amenities is a developer willing to provide?
6. General: will the development be an asset to the City?

It is in the course of these processes that a design and energy system review must be interjected. Given the number of large developments being proposed in Boston at any given time during recent years, smaller projects tend to receive only cursory review and, thus, move more quickly through the agency. They are not large enough to justify major design or energy system reviews, given staff and time constraints.

On the other hand, the BRA generally becomes involved in larger projects earlier in the design process than is true for smaller projects. This means there is more planning time, less investment in design decisions on the part of developers, and, consequently, greater opportunity for influencing the developer's proposed building design and selection of an energy system. Many issues, such as site layout, infrastructure planning, overall architectural treatment, floor area ratios, height limits, traffic and pedestrian circulation, public amenities, sight lines, and others are negotiated. The BRA architectural staff, all of whom have had training in energy conscious design and have followed this project with interest, attempt to balance these many issues against each other and against concepts of energy-efficient design.

Given the many trade-offs which must be made during this negotiation process, it can never be guaranteed that the energy-conserving design features will always survive. Our experience to date is one of moderate success. An interesting generalization about our successes, however, can be made: more experienced and sophisticated developers are much more receptive to energy conservation issues, while the rest fail to perceive their own self-interest in conserving energy through design, being more narrowly focused on first-cost items.

As the larger issues are settled, the developer's architects proceed with designs which are submitted periodically to the BRA for review and approval. Here again, negotiations may or may not go well. If larger, more pressing BRA concerns, such as floor-area ratio, architectural compatability with local environs, building height, traffic circulation, etc., are not at issue, room in the design negotiations may exist for further attention to energy conservation issues. More than occassionally, however, the BRA must exhaust its bargaining chips to obtain concessions on fundamental urban planning issues.

This does not imply in any way that the BRA does not place high priority on energy conservation, but, rather, that it, like all other BRA priorities, may receive less than full attention from time to time when negotiations with developers become too complex, too protracted, or too sensitive. In these situations, the BRA must be content that the developer must, at a minimum comply with ASHRAE Standard 90-75, adopted as Article 20 of the Massachusetts State Building Code.

A brief review and discussion of the specific legal processes employed by the BRA follows.

A. 121A

These projects are typically small, HUD-financed housing projects, which arrive at the BRA all but built and seeking only a negotiated tax agreement. While the BRA legally has design review powers, developers already have invested a great deal in producing designs which meet HUD standards and are, thus, reluctant to make significant changes. Instead, minor recommendations are made to the developer, such as increasing the R-factor on North walls and hot water pipes, finding heat pumps with higher coefficients of performance, or altering facade treatment or fenestration to reduce conduction losses or optimize solar gain. Typically, these projects are on such tight budgets that even modest design alterations can be problematic.

B. Commercial Area Revitalization Districts

CARD projects, like 121As, receive primarily financial review and only infrequent and cursory design review, usually restricted to building facades.

C. Planned Development Areas

PDAs, of which there may be one per year or less, generally arrive at the BRA early in the design process since they seek special, beneficial status under the Zoning Code and frequently generate political controversy in the communities for which they are planned. A recent application received the following response from the BRA in accordance with the BRA's energy policies, in addition to similar comments regarding street plans, infrastructure, and other issues:

> "Housing should be oriented to take maximum advantage of solar energy, and its design should be more compatible with architectural styles in the area. While single family housing is predominant in the area, a limited amount of sensitively designed cluster housing might be appropriate for both energy conservation and topographic reasons. Information on the projected cost of heating and cooling on a BTU/ft^2/year basis, calculated per the procedures set forth in Article 20 of the State Building Code, should be provided for the different housing types proposed.
>
> As you know, the PDA process anticipates considerable dialogue between the developer and the reviewing agencies. A project of this magnitude will require many adjustments to arrive at a plan which will be acceptable to all concerned parties."

These issues, along with others raised by community groups and abutters, will be negotiated and compromises will be made over many months.

D. Zoning Variances

Virtually no opportunity for energy system review exists in this process. Rather, the BRA plays a more passive role in this procedure, recommending approval, occasionally with conditions, or denial of variance applications to the Zoning Board of Appeals. The effect of this process on the energy efficiency of Boston's structural stock depends on the ability of the zoning staff to judge the net effect of a variance on the structure in question and its neighbors. Given the large number of variance applications handled by this staff annually, it is not realistic to expect quantitative analyses of energy considerations, except perhaps for larger projects for which the review processes may take longer and allow time for such analyses to be done by the developer.

E. Urban Renewal Areas

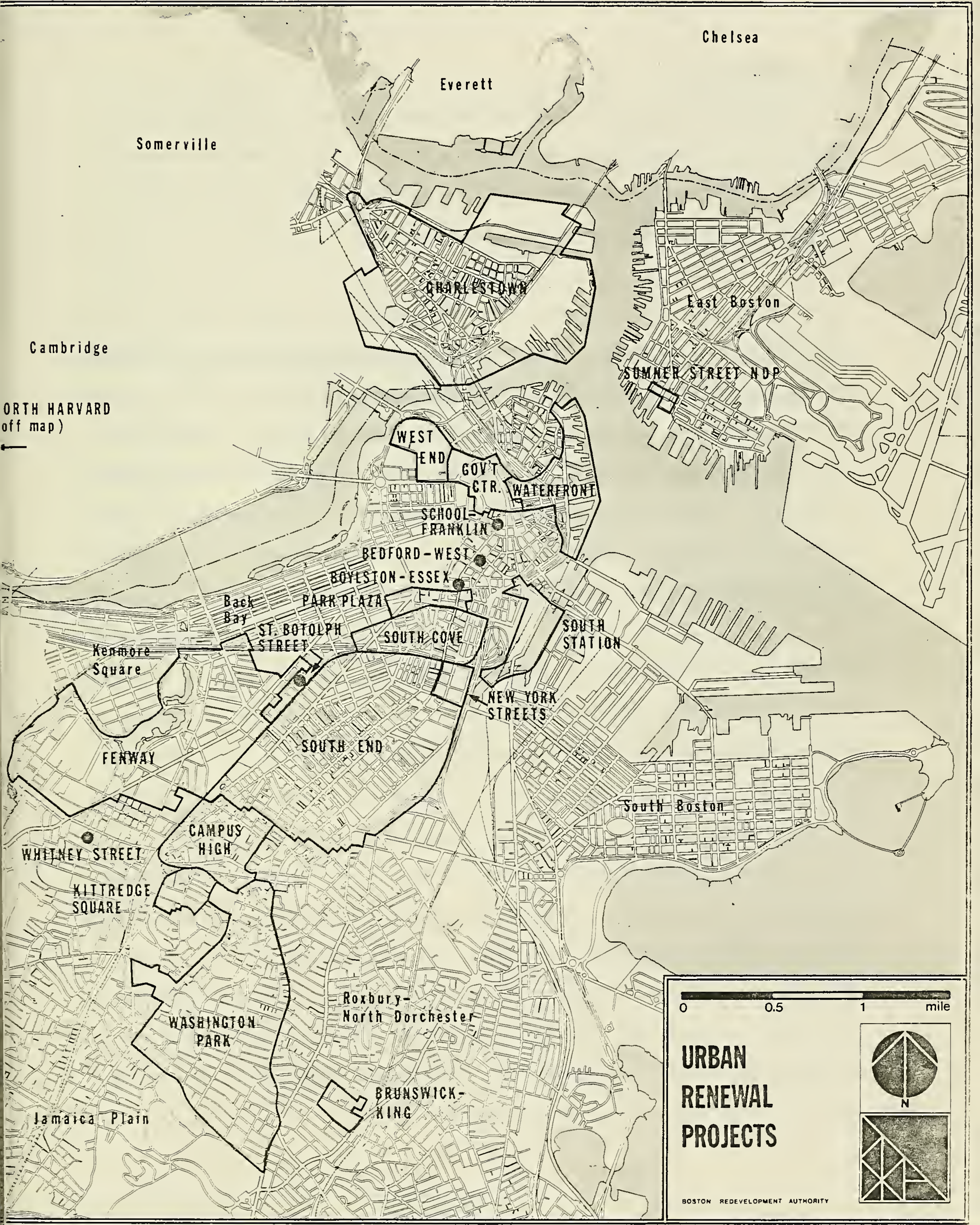
Urban Renewal Areas (URA) and City-owned property are essentially in the same category since most City-owned property is in URAs, and the BRA has complete design review in both cases. Usually, these parcels and/or buildings are either sold or leased to the winner (designated developer) of a design and development competition, wherein developers submit design proposals to the BRA in response to a Developer's Kit (request for development proposals). Proposals are judged on the bases of financials, design, proposed uses, track record of development team, and other criteria which may change from time to time.

Most recently, pursuant to new BRA energy policies, the following items have been included in such Developers' Kits:

- "The design of the development should be sensitive to energy conservation and consider solar orientation and window treatment."
- "Life cycle costing should be included in decisions on energy systems."
- "To maximize energy efficiency, the design should consider solar orientation and window treatment. Any glass enclosed areas proposed should provide for sun shading and natural ventilation in warm months to minimize energy use for cooling."

Specific items watched for in proposals or design review include:

1. Control of summer solar gain.
2. Use of natural daylighting.
3. Thermal storage capability.
4. Shade and wind impact on other buildings.
5. Use of variable air volume (VAV) air handling systems.


Chelsea
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East Boston
Cambridge
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CTR.
WATERFRONT
SCHOOL-
FRANKLIN
BEDFORD-WEST
BOYLSTON-ESSEX
Back
Bay
PARK PLAZA
ST. BOTOLPH
STREET
SOUTH COVE
SOUTH
STATION
Kenmore
Square
NEW YORK
STREETS
SOUTH END
FENWAY
South Boston
CAMPUS
HIGH
WHITNEY STREET
KITTREDGE
SQUARE
Roxbury-
North Dorchester
WASHINGTON
PARK
BRUNSWICK-
KING
Jamaica Plain
0
0.5
1
mile
URBAN
RENEWAL
PROJECTS
N
BOSTON REDEVELOPMENT AUTHORITY

F. Publications

One important way of smoothing and shortening the proposal and/or development review process and improving the quality of development in Boston is to notify the development community at large of BRA policies, preferences, and criteria via publications written expressly for this purpose.

The BRA is presently preparing a formal statement of policies which has been preceded by two publications entitled Boston Tomorrow: Issues of Development and Boston Tomorrow: Background on Development which are available to the general public and have been mailed to over 7,000 real estate developers, architectural firms, and other development-related companies who do business in Boston. These reports contain descriptions of Boston's energy systems and their problems and opportunities, and lay the foundation for the energy policies which will follow and which are found in this report.

In addition, the BRA releases numerous other publications each year, such as the Developers' Kits discussed above and elsewhere in this report, which advise developers of the BRA's expectations.

G. Time of Use Rates

It was hoped that a new set of single family Time of Use Rates (TOUR) for the electric utility (BECo) would be in place by the time this was written and that new TOUR would provide the BRA with a new tool for helping to level BECo loads. Unfortunately, that is not the case. The existing single family TOUR, put in place four years ago, have been characterized as being all stick and no carrot. See Table 2 for a comparison of BECo standard rates and the experimental TOUR now in effect.

Large commercial developments are already acting in their own interests by responding to BECo's new load management and conservation campaigns and negotiating special service contracts with BECo which approximate a TOUR. The BRA was hopeful, however, that it could begin to prod smaller developers of single family units (apartments and condominiums) into use of TOUR by conditioning tentative designations on use of TOUR.

BECo reports, however, that, of the 500 orginal experimental TOUR customers, only 80 or so remain. Most of the experimental group found that the meter charge, the inflexibility of residential loads generally, and the immovability of certain loads (refrigerators) made it virtually impossible for them to shift enough peak load to shoulder or off-peak times to realize any savings. BECo claims that a TOUR can only be effective with adequate incentive, such as an off-peak rate of $.01/Kwh, and the substantial reduction of meter charges presently necessitated by the high cost of special meters.

Rather than approve a new TOUR, however, the Massachusetts Department of Public Utilities focused on an improved, compromise set of general residential rates, which do not provide the BRA with the special vehicle it sought.

Table 2

RESIDENCE RATE B
(for all-electric single family units)

Service Charge	$3.00/month	
Energy Charges		
- Summer (July-October)	5.313¢/Kwh	0 - 350 Kwh
	3.540¢/Kwh	351 - 750 Kwh
	5.610¢/Kwh	751 - 1000 Kwh
	5.230¢/Kwh	1000 - total use
- Winter (November-June)	5.313¢/Kwh	0 - 350 Kwh
	3.540¢/Kwh	351 - 750 Kwh
	5.313¢/Kwh	751 - 1000 Kwh
	3.160¢/Kwh	1001 - total use
Fuel Charge	variable/applicable to all Kwh	

OPTIONAL RESIDENTIAL TIME OF USE RATE

Meter Charge	$6.46/month	
Energy Charges		
- Peak*	19.000¢/Kwh	11 a.m. - 5 p.m.
- Shoulder	7.500¢/Kwh	9 a.m. - 11 p.m. 5 p.m. - 10 p.m.
- Off-peak	2.100¢/Kwh	10 p.m. - 9 a.m.

* Peak charges not in effect from September through May

Developers' kits

V. THE ENERGY SYSTEMS DEVELOPERS' KIT

Occasionally, the BRA is in a position of controlling a significant amount of contiguous acreage or, at least, being able to anticipate what will happen to that acreage in the near future. These are situations in which a community scale energy system of some sort becomes possible, but only under a specific set of circumstances. Generally, the parameters of possibility are:

1. the load must be dense and diverse enough;
2. development timeframes must mesh properly;
3. private investors must be willing to undertake responsibility for
    a. preliminary studies,
    b. design work,
    c. capital formation,
    d. marketing, and
    e. operation and maintenance;
4. the investors must convince the City that the project will succeed; i.e., that
    a. cash flow projections are soundly calculated,
    b. the project is adequately capitalized,
    c. energy will be provided to consumers less expensively than otherwise available,
    d. it is technically competent,
    e. its own energy supply is reasonably assured, and
    f. that the developer is capable.

First, a developer of such a system must be identified, probably, in one of two ways: 1) a parcel owner/developer in a target area will wish to undertake the project, or 2) a third party or energy systems specialist will respond to a Developers' Kit (RFP) issued by the BRA.

The BRA regularly issues Developers' Kits to initiate competitions between developers for the redevelopment of a City owned or controlled site. In substance, no two kits are ever alike, although portions of them are boilerplate. SAND staff adapted such a Developers' Kit for a hypothetical competition for the development of a Large-Scale Energy System (LSES) (see Appendix A).

A LSES Developers' Kit must ensure that all of the questions raised under items 2, 3, and 4 above are answered thoroughly. Assuming those responding to the Kit demonstrate adequate qualifications and ostensibly feasible development plans, respondents then might be asked to contribute additional funds for engineering analysis of the site or the proposals submitted which would identify whatever additional information might be needed before final proposals could be submitted. Preliminary discussions with a few such LSES developers indicate that such additional studies may be needed only if the loads and installation costs are not reasonably ascertainable.

After selection of the most qualified development team, the LSES developer would, with the BRA's support, arrange to interlock its development schedule and energy systems with those of real estate developers and property owners at the site and proceed to final design and construction. The BRA presumably would not participate in the negotiation of contractual arrangements between the parties once they had been "married".

While the Authority has not yet committed itself to use of this experimental procedure, staff are currently laying the groundwork for its potential use at Columbia Point, where it is anticipated that 1200-1600 units of housing will be built adjacent to numerous other large scale energy users, such as a college campus, an exposition center, three grade schools, a newspaper printing plant, office buildings, an archives, and others. After completion of a prefeasibility study, it is hoped that a strong case can be made for obtaining a commitment from the Authority's Board to issue the LSES Kit and pursue the process to successful implementation.

Footnotes

FOOTNOTES

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Appendix A

Appendix A

Large Scale Energy Systems Developer's Kit

The enclosed developer's kit marks an innovative step forward in the development of the City of Boston and in the field of energy systems planning. Never before has a major Northeastern city acted so boldly in responding to the economic and environmental plight which has resulted from New England's dependence on imported fossil fuels by inviting the development of an energy system scaled to meet the needs of an entire development area.

The Boston Redevelopment Authority, in issuing this kit, seeks from the private sector proposals which are not limited by tradition or industry standards. We hope, rather, that interested parties will feel challenged to design creatively and work closely with the Authority in building a system which can serve as a model of energy efficiency and of private and public sector cooperation.

Let it not be said that Boston was too entrenched in its ways to fight back when threatened by the high prices and precarious supplies of oil and natural gas. Instead, let us invest in a safe and prosperous future for our City.

Sincerely,

Robert J. Ryan, Director
Boston Redevelopment Authority

PROCEDURES FOR THE SELECTION OF AN ENERGY SYSTEM FOR THE DEVELOPMENT AREA

The overriding standard to be employed by the Authority in analyzing development proposals is the determination of maximum benefit to the City. The demonstrated experience, skill and financial strength of the development/design team are the most significant criteria.

The Authority's review will involve:

- o Evaluation of the energy developer submissions as outlined. Development teams, which are in the opinion of the Authority qualified for further consideration, will be invited to make a formal presentation to the Authority.

- o The finalists will then be asked to prepare a full engineering design and a detailed financial submission based upon further BRA terms and guidelines.

At any time, the Authority may request additional information from any developer.

For the (submission date) submission, the Boston Redevelopment Authority requests that energy system developers submit, no later than 5 P.M. on (submission date) to Robert J. Ryan, Director, Boston Redevelopment Authority, City Hall, Room 925, One City Hall Square, Boston, MA 02201:

1. A certified check of (check amount) drawn to the order of or assigned to the Boston Redevelopment Authority. The Authority is under no obligation to earn interest. (Retained amount) of the fee will be retained by the Authority for the processing of the submission. However, the remaining (remaining amount) deposit shall be returned promptly to unsuccessful applicants.

2. Energy developer submission:

   a) Letter of Interest including introduction of energy development team.

   b) Proposal of energy system in compliance with the outline presented herein. Proposal must consist of the responses solicited in Parts III through VI of this developer's kit.

The Authority reserves the right to reject any and all proposals.

PART I

Request for Proposal

The Boston Redevelopment Authority is presently directing the development of (development name) located at (development location). The developer for the project recently selected by the BRA is (developer's name). Careful energy planning for new development is of great concern in Boston inorder to restrain the economic hardships and uncertainties associated with our energy dependence. To effectively and equitably meet this goal, the policy of the BRA is to solicit proposals from capable engineering and energy firms for an energy system design to meet the new development's thermal and electrical energy needs. The firm selected for this task will work closely with the BRA and developer through all phases of the project - from detailed and compatible system design, to implementation and financing/ownership arrangements.

The proposed energy system must address the entire development area and the entire energy load - heating, cooling and electrical. The proposals will be rated mainly on merits of energy efficiency, fuel requirements, system reliability, cost and compatibility with the proposed development, and the proposers' ability to perform the entire task. This RFP is designed to be flexible enough to accommodate the variety of energy supply and management technologies, yet structured enough to allow the BRA to consistently evaluate the merits of each proposal. It is suggested that applicants read A Concise Guide to Energy Use and Planning in Boston, available from the Authority, prior to formulating a response to this kit.

The BRA cannot be held responsible for the accuracy of the development area description presented in Part II and cannot assure that present plans are not subject to change.

PART II

Description and Energy Requirements of New Development

(The purpose of this section of the developer's kit is to present sufficient information regarding the new development for an energy system to be proposed in adequate detail for the RFP. The actual data presented here will thus be dependent on the development project being considered. The data format will depend on the state of the development planning and particularly whether the developer has already performed an energy load calculation for the project. It is suggested that the load calculation be left to the developer for the following reasons - (1) the developer may be more inclined to design in an energy conscious manner, (2) accurate load calculation requires substantial work and knowledge of the development design characteristics which may be more efficiently handled by the developer, and (3) a variety of load calculations by the energy system proposers may render the proposals difficult to consistently compare. The load calculations should be done in accordance with the industry standards and procedures and include all energy requirements. The information must be neatly presented and include daily and seasonal load variations along with total and peak demands. The buildings should be broken down into zones small enough such that within each zone the load characteristics are the same.

Development of multi-building energy systems require special attention regarding developer/owner/occupant relationships and the time schedule on which the various loads will come on-line. Energy flows between buildings require cooperation between independent parties which should be clarified before a system dependent on these flows is implemented. Temporary plans for the period of development may be necessary to meet existing demands before the entire development is completed.

The following list presents the type of information which should be included in this section at the RFP:

1. Description of development project

   a. site plan, building orientation and dimensions
   b. floor plans
   c. surrounding resources - body of water, district heating system, solar access and roof space
   d. anticipated developer-consumer relationships - obligation of consumers to use energy system
   e. development time schedule-anticipated schedule of energy loads coming on-line

2. Load characteristics

   a. floor areas, occupancy, and usage (day and night)
   b. lighting load
   c. machinery, fans, and other electrical loads
   d. internal heat gains - source and location
   e. solar gain
   f. hot water requirements

g. heating load calculation - by zone, daily and seasonal variation, average and peak
h. cooling load calculation - by zone, daily and seasonal variation, average and peak
i. ventilation requirements)

PART III

Non-Technical Description of Energy System

This section requires a general description of the proposed energy system and a series of short responses concerning specific aspects of the system which must be considered. Responses should be understandable by someone familiar with the technology but not the detailed engineering *per se*. Please keep responses concise and informative. Length of responses should be limited to the amount specified, however, due to the diversity of energy systems, some demands may not be particularly applicable and others may require exceptional attention.

A. Provide a descriptive narrative of the proposed energy system. Response should cover the major system components or sub-systems, the thermodynamic concepts on which the system is based, fuel requirements, and design and peak output specifications for all energy forms and loads. Response should be limited to two (2) pages, single-spaced.

B. For each of the following considerations, provide comments and numerical specifications as appropriate for the proposed system. Analysis of electricity consumption from the utility grid should consider the primary fuel required for the electricity generation. Responses should average ½-1 page.

   1. Fuel requirement - kind of fuel(s), rate of consumption (design and peak), total annual consumption.
   2. System costs - capital cost breakdown, fuel cost, O/M, etc.
   3. Fuel supply reliability to Boston area.
   4. Fuel delivery and fuel storage requirements on-site.
   5. Environmental considerations - average and peak pollution production (air, thermal, noise).
   6. System efficiency and conservation characteristics.
   7. System flexibility - ability to effectively deal with future uncertainties in fuel price and supply, regulatory requirements, new technology, etc.
   8. System implementation strategy - design and performance of system to accommodate staggered load growth as development area progresses and to effectively deal with uncertainty regarding load magnitude and consumer utilization of energy system.
   9. System reliability - maintenance schedules, estimated down time, back-up capabilities.
   10. Impact on developments plans - architectural modifications, zoning considerations, design and time requirements/constraints for developers.

11. Institutional requirements - licenses, approvals required by City, applicable regulations, utility interface.

12. Relation of system to energy situation and goals in Boston.

PART IV

Economic Analysis of System

A. Life-Cycle Cost Analysis

To properly analyze and compare the economics of of the proposed energy systems a life-cycle cost (LCC) analysis is required. The objective of this analysis is to compute the system's total present value, which equals the sum which, if invested in the base year at a given interest rate, would provide for all capital and operating costs. The analysis requires the identification of all costs and revenues throughout the system lifetime and the translation of these figures to their present value. Necessary in this analysis is the assumption of values for various critical economic parameters. The BRA has made the following assumptions and requests the LCC analysis be performed using these values and the format provided below. An additional LCC analysis can be performed with other assumptions or formats provided justification of the modifications is included.

Economic Assumptions

Base Year:
Discount Rate (real): %
Fuel Price (base year)
    Oil: %
    Gas: %
    Electricity: %

System Lifetime: 40 years
Energy Price Escalation Rate (real):
    Oil: %
    Gas: %
    Electricity: %

Cost/Revenue Flow of System

Use the table on the following page or include your own charts to demonstrate the cash flow of the system over its lifetime. Include as footnotes any explanation which is necessary to clarify the entrants (or lack of). Dollar figures should be calculated in real base year dollars, and Present Value (PV) is calculated as follows:

$$PV = (Y) \frac{1}{(1+r)^n}$$

where r is the discount rate in real terms and Y is the total expenditure in year n. Fuel costs should be escalated each year at the appropriate real fuel escalation rate (see Economic Assumptions).

B. Financing Analysis

The financing of the energy system requires consideration particularly for capital intensive options. Applicants will be responsible for arranging financing in an effective manner. This requires proving incentives for equity participation from either within the firm or from third-party investors. Financing costs and taxation considerations, such as tax credits and depreciation, also require attention.

In particular, describe the proposed financing arrangements for the energy system.

1) Who are the equity participants?

2) Demonstrate their economic incentives by explicitly showing their cash flows over time including effects of taxes and financing charges.

3) Calculate each participant's rate of return on investment.

4) What is the estimated cost to consumer per unit of energy for each energy type in current constant dollars for each year of operation?

5) How does the financing effect the economics of the system?

6) How is the cash flow analysis affected by the following events:

    i) 10% drop in the price of oil, natural gas, and electricity.

    ii) 10% rise in the price of oil, natural gas, and electricity.

PART V

Organizational Structure of Proposer

A. Work Plan

1) Provide a work plan for the implementation of the energy system. Show major tasks and time required for planning, design, engineering, acquisition of components and parts, construction, etc.

2) Are all components readily and commercially available?

3) Indicate any work performed by a sub-contractor and assurances of quality sub-contractor performance.

4) What arrangement and contractual relationship is required/desired with the site developer?

5) What are the foreseen problems and contingency plans?

B. Qualifications

1) Provide a company description, including affiliations, and resumes of the proposed staff assigned to perform the work required.

2) Describe experience and qualifications the company has planning, financing, designing, installing, and operating energy systems of the sort proposed.

3) Submit a certified financial statement showing itemized assets and liabilities.

PART VI

Detailed Description of Energy System

To the extent that the proposed system is now designed or a similar system already designed by the proposer, provide technical drawings and specifications indicative of the engineering involved and supportive of your cost predictions.

Table for Life-Cycle Cost Analysis

Expenditure (000s dollars, base year)

	Design/	Capital	Operational			Equip	Salvage	Other	Yearly	PV
Year	Engr.	Equip.	Fuel	Mangnt	Maint	Repl/Rep	Value	(Specify)	Total	To
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										
:										
n										
								Total PV = LCC		

DISTRIBUTION LIST

Internal

Allen
Bailey
Bourque
Brown
Carlaw
Derbentli
English
Fischman
Garver
Howard
Koff
Kroin
Mathieson
McCann
Mertens
Newton
Otis
Ryan
Shaklik
Sims
Smith
Zeigler

External*

Houghton, ANL
Hrabak, ANL
Tchanz, ANL
Massachusetts Executive Office of Energy Resources (5)
American Planning Association (5)
U.S. Department of Energy (5)

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* Argonne National Laboratory (ANL)

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